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Study of the thermodynamical parameters using Tsallis statistics with flow velocity at freeze-out in relativistic heavy-ion collisions

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The thermodynamical properties of the high-temperature and high-density system produced in relativistic heavy-ion collisions can be understood with a systematic study of the produced hadrons' transverse momentum (p_{T}) spectra. The p_{T} spectra of these hadrons can be described well by a distribution using the Tsallis statistics. The Tsallis parameters q and T measure the degree of deviation of the system from an equilibrium state and the effective temperature at freeze-out conditions, respectively. The Tsallis formalism with the inclusion of flow velocity can describe the p_{T} spectra from low to high p_{T} ranges. This formalism overcomes the drawback of the limited pT range description through the blast-wave fits of the p_{T} spectra.
In this work, a detailed study of the p_{T} spectra of the identified charged particles (pions, kaons, protons) as well as all charged particles in the heavy-ion collisions at the Relativistic Heavy Ion Collider (RHIC) energies (from $\sqrt{s_{\mathrm{NN}}}$ = 7.7 GeV to 200 GeV) and at the Large Hadron Collider (LHC) energies ($\sqrt{s_{\mathrm{NN}}}$ = 2.76 TeV to 5.44 TeV) are performed using the non-extensive Tsallis statistics. The extracted Tsallis parameters are found to be dependent on the particle species, collision energy, centrality, and fitting ranges of the p_{T}. With increases of the collision energies, q increases in a systematic manner whereas T has a decreasing trend. It is observed that the parameters q, T, changes with increasing p_{T} fitting ranges and at mid p_{T} region the parameter are found to be unchanged, which can describe the physics of the systems. The Tsallis parameters and the quality of fitting are found to follow a mass ordering. The contribution of the flow velocity of the particles are considered with the Tsallis statistics through Tsallis blast-wave (TBW) model, which is found to have a better description of the p_{T} spectra of different particle species. The thermodynamic parameters and extracted energy density at the kinetic freeze-out will be presented as a function of collision energy.

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